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ABSTRACT

The difference between weight and mass, the desirability of "metric only" instruction, and the importance of decimals are among the topics discussed in this paper presented at a metric education conference. Comments on the potential of SI metric as a universal language and on efficient methods of converting to the metric system also are included. (DT)

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FACTS OF LIFE AND LIVING FOR A METRIC TOMORROW TODAY

A Paper Presented at

Fourth International Conference on Metric Education

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and held at

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FACTS OF LIFE AND LIVING FOR A METRIC TOMORROW TODAY[1]

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An ad-man with an overworked sense of humour, I'm sure, coined the travel industry slogan, "Getting there is half the fun." Accordingly, in the taxi to our home airport, I deemed it prudent to listen rather carefully to our morning newscaster yesterday, seeking some hint of snows in New England, icing conditions over Georgia, fog in the Mississippi delta . . . or other harbinger of unexpected travel adventure.[2] "Ten below and clear in Truro," said the announcer. Hundred kilometre per hour winds had packed the week's twenty to thirty centimetres of drifting snow. "Winds now twenty kilometres per hour from the southwest. Barometer about one hundred kilopascals, and steady." With just a few dust-devils of

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[1]Contributed paper, Fourth International Conference on Metric Education, New Orleans, 22 January 1977.

[2]Anticlimatically, the southbound trip was wholly free of seasonal complications. Northbound, in contrast, was destined to approach total disaster--long hours on the tarmac at Chattanooga (an unscheduled stop) waiting for fog to lift at Atlanta; apparent chaos at Atlanta while, with other airports closing due to snow, jets circled in the overcast, one of them carrying the captain and first officer for our ongoing flight; two missed connections out of Boston; then 72 hours to unwind, in anticipation of the arrival of strayed luggage. As with the jet-age odyssey, so with SI conversion: you win a few, you lose a few, but somehow retain both optimism and sense of humour!

swirling snow on freshly ploughed runways at Halifax International, it was an auspicious morning for flying. I'm delighted to be with you in New Orleans . . . and I think we'll find food for discussion even in the essentially preliminary remarks we've shared thus far.

Snowfall in centimetres, rainfall in millimetres, temperature in degrees Celsius, windspeed in kilometres per hour, atmospheric pressure in the appropriate SI unit, the kilopascal . . . Canada's weather has shifted sharply to international metric--with only a few, tongue in cheek I do trust, suggesting that a really bad winter might be due to having moved to the Celsius scale.

Fact 1. Modern international metric can be related to the real world, and its structure and simplicity can promote understanding of fundamental concepts.

On my desk back in Nova Scotia is a clever metric learning aid, a cardboard "Metricube" distributed by the Metric Commission, Government of Canada. Ten centimetres by ten centimetres by ten centimetres when duly assembled, the cube clearly has a volume equivalent to the litre. Filled with water, its mass would approximate the kilogram. Five faces of the cube, as assembled, are colourfully crammed with useful metric facts. The face which deals with mass, however, carries a footnote which has greatly disturbed me:

> To most people the difference between weight and mass is not important.

Now weight is a force, a gravitational force; mass is an

invariant, a measure of the quantity of matter. This is not a physics lecture, you understand; it approaches a statement of the self-evident. Today's child has seen an astronaut, obviously substantial, obviously possessing mass, functioning in a condition of weightlessness. He has seen, too, the easy stride of the Earthman in the low gravitation of the Moon. Mass. Weight. Given gravity, we measure one in terms of the other. Measurement by analogy. To do so is convenient, much as we measure temperature in terms of the length of a mercury column. But mass, measured in kilograms, and force, measured in newtons, are two entirely different things.

Practical measuring of basic concepts today is needlessly complex. Pound may mean mass or force, depending entirely on the context. The same measurement word, used in two utterly different ways. Calorie, British thermal unit, watt, atmosphere, horsepower . . . units promote confusion, and their interrelationships are needlessly complex. It seems to me that when force--invariably--is measured in newtons, energy in joules (newton-metres), power in watts (joules per second), and pressure in pascals (newtons per square metre), that a generation that talks energy crisis and power ratings will have little difficulty with the essential concepts involved.

Yes, mass and weight (force) are two very different concepts, with entirely different metric measures. Along with length, area, volume (capacity), and the relatively few others, they can provide, in a simple, satis-

factory fashion, in basic metric, for most of man's day-to-day measurement needs.

Fact 2. "Dual dimensioning" is an exercise in futility: the "harder" the conversion, the greater the "immersion," the better the metric learning.

"Ten below and clear," according to the announcer on the taxi radio. Degrees Celsius, of course . . . so why say so! On 31 March 1975, Canada's Metric Commission ran its now-famous full-page ad, "Say Goodnight to Fahrenheit." "Cold turkey" conversion led, in most papers, on most radio stations, to "Celsius only" reporting, following the two previous weeks of introductory "duality." Very quickly, Canadians were learning the Celsius scale by hearing it and experiencing it, without reference to Fahrenheit degrees. After one year, after the succession of four seasons, many would concede that the feel of the Celsius scale was "in their bones." Those radio stations which, contrary to recommendations of their national association, persisted with both Celsius and Fahrenheit readings promoted, unwittingly, a kind of dependence on the latter. If both readings were available, the mind "heard" the one that was familiar. This should be no surprise. The British Broadcasting Corporation, I understand, persisted with "dual readings" for all of seven years, then discovered that no one had heard what they called "centigrade." Canadian stations, when asked to defend such a policy, make references, pathetic references, to the "old people" and to ununderstanding American tourists.

"Dual scales," pedagogically, simply don't work. You don't learn the new in terms of the old; rather, you revert to the old, the comfortably familiar, and fail to internalize the new. If you "weigh in" on bathroom scales that read kilograms, don't even ask, "How much would that be in pounds?" On rulers at the college, our solution has been simple. Given centimetres and inches on existing metre sticks, masking tape goes over "inch" readings. On new merchandise, it's "metric only," of course, and units and symbols are strictly SI.

Good learning of basic metric is facilitated by "hard conversion," where bottles, packages, and modules represent convenient, logical metric sizes. America has been struck by the litre of "uncola," a stroke of promotional genius and a perfect instance of hard conversion. The contrast would be the pound box of chocolates, soft converted to 454 grams . . . but, for all intents and purposes, still one pound. Canadians now can buy sugar in kilogram packages, and ice cream in litre tubs.[3] You really can tote a five kilogram bag, and learn kilogram! But Canada's pulp and paper industry, a major sector in the national economy, has greatly disappointed metric students. Faced with, as one option, conversion to the convenient, efficient, but wholly new, international "A" sequence of paper sizes, the industry chose to "soft convert"

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[3]Indeed, our family "metric" joke involves the day last Summer when my wife, who's very metric, asked our daughter, who's very metric, to pick up a pound of icing sugar. The closest she could come was 500 grams.

present sizes as Canadian standards. So, in effect, you buy 8½ by 11 inch paper, but give it a new metric name.[4]

Learning SI metric, for most of us, is like learning a new language . . . in fact, it is learning a new language. Languages are best learned by immersion, experience has shown. You think in the language, rather than translate. As we have seen, Canadians have learned Celsius by living Celsius. There may be a lesson there for us all.

Fact 3. Metric is decimal--a decimal measuring system in an increasingly decimal world.

From minicalculator readouts to the printout of computer and bank balance, we live, whether we know it or not, in an increasingly decimal world. Scale diagrams, for example, may be in tenths of an inch; machine parts in thousandths (mils); and angles in decimal degrees. Here in New Orleans, agreeably immune to the touristy delights of the French Quarter, I find particular fascination in the cosmopolitan bustle of the riverfront. Safe, we trust, behind its levees, but a frightening five to ten metres above the level where we are convened, the mighty Mississippi carries, as it has for decades, the varied produce of world trade. As I say, an increasingly decimal world. At the ferry wharf across at Algiers, I find the critical river level measured off in traditional fashion. No, not the "mark twain" of the riverboats . . . but feet above mean

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[4]You win a few, you lose a few--to reiterate. For a Canada aspiring to truly international standards, this one would seem to have been a singularly unfortunate loss.

sea level, to 17.0, in decimal feet. Halves, quarters, and eighths still persist in a few contexts, of course, notably the stock market and the subdivisions of old measures, but in most day-to-day dealings, we live increasingly decimal lives.

With its traditional heavy emphasis on common fraction and mixed number manipulation at upper elementary level, the school mathematics program, both old and "modern," is going to need rather fundamental reconsideration if it is adequately to serve a predominantly metric and decimal tomorrow. A dollar of 100 cents . . . a metre of 100 centimetres . . . but how early should we extend place value to decimal subdivisions, and what should be the continuing role of the "common fraction"? Basic, as well, will be matters of accuracy and precision, of how many decimal places are appropriate in problem data and in pupil responses. A world of 7 inch wheels, a world which took $\pi = 22/7$, largely ignored such questions, certainly at elementary level. I suggest, from experience with future teachers, that such questions are going to have to be approached with clear insight and with particular resourcefulness, but that in no way can they be downplayed. I shudder at rulers divided to half centimetres, bathroom scales to half kilograms, for example. Half-centimetre precision implies "more than one-fourth, less than three-fourths" type thinking; and such thinking, I submit, does not promote truly decimal patterns of thought. Try this exercise: divide one metre into three equal parts. How

long will each part be? If the metre is of drapery material, measured to the centimetre, 33 cm is a reasonable answer. In a machine shop, working to the millimetre, 333 mm is the correct response--assuming no loss in cutting. This kind of thinking, as opposed to a rote "$33\frac{1}{3}$," is going to take getting used to, for us old-timers at least!

For girl-watchers with a suitably metric point of view, a "perfect 36" converts, I would say, to 90-60-90 (centimetres, nicely rounded), not to the 914-610-914 (millimetres) that you see on some "awareness" posters!

Fact 4. SI metric has the potential of becoming a universal language, understood and used by all men, employed in all trades . . . if we don't each "do our thing."

On my office bookshelf, one of the things I would reach for in a moment of relative leisure, is a textbook in Esperanto, the proposed universal language. I enjoy dipping into it as intellectual exercise, however impractical, however utopian, the notion. A Canadian need not venture beyond his own borders to discover the inherent limitations of English and French.[5] The idea of a world language may well be utopian, at least at this point: that of a universal measurement language certainly is not. Whatever their name in a given language, the units of SI metric are well on their way to a kind of universality. They will be known and used in all nations . . . but will only be truly

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[5]As a northern principal, the author had one pupil who tried, without notable success, to instruct him in elements of inland Cree.

universal when they are adopted by all sciences, all professions, all trades, and all marketplaces. Part of my personal required reading each month is Scientific American . . . very "metric," of course, but, from angstrom to parsec, a babel of non-SI usage--reflecting, I fear, the "state of the nation" in the scientific community today.

A relatively limited metric vocabulary, largely identifiable at this point, I believe, is likely to satisfy many of tomorrow's day-to-day needs. I'm thinking of basic words like metre, centimetre, millimetre, and kilometre . . . kilogram, gram, milligram, and megagram (metric ton) . . . litre, millilitre, degree Celsius, and hectare. Further, such additional measurement terms as newton, joule, watt, pascal, volt, and ampere, will, if only because of their simplicity, with good science teaching and high general educational levels, enter ordinary life to a significantly greater extent than they or their counterparts do today.

One annoying little problem, I'm sure, will be metric slang. I've heard "kilo" for kilogram, em-el for millilitre (mercifully replacing cee-cee!) . . . and proliferation is more than likely.[6] It would be unfortunate, surely, to encourage such detraction from the simple elegance of SI.

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[6]One of the better stories going around the Conference involves the meticulous European butcher who, on being asked for a "kilo" of sausage, enquired whether that would be a kilogram or a kilometre.

In the lobby of one of your more recent national conventions--I cherish such memories--I was buttonholed by a singularly articulate American who assured me (and all others who would listen) that "metric" was, among rather diverse other things, a communist plot and an affront to right-thinking theology.[7] Conversion would be, above all, an infringement on "freedom." Here, I beg to disagree. "Doing one's thing," undeniably, has much to be said for it . . . but I see a far greater "freedom" in a universality of accepted measures, a system reflecting the "state of the art" in measurement science and designed to facilitate communications at all levels. SI-metric is but the means. Optimal communications are the all-important ends. When someone tells me, in effect: "We're the greatest. Why can't others switch to our way of doing things!" . . . I can only reply, as kindly as possible, "Get your head out of the sand."

Fact 5. SI introduction is an ideal time to tidy up much that is illogical in our measurement lives.

On one of those dead Monday mornings when half the class was asleep, I told my "methods" students that in a metric and decimal age, not all would change: for example, hens would still lay eggs by the dozen. I think they dutifully wrote it down. But we know that hens do not lay eggs by the dozen . . . men package them that way,

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[7]The occasion, for the record, was the Dearborn, Michigan, conference, sponsored by Western Michigan University, 22-24 November 1976, and the speaker a retired toolmaker . . . but such arguments are being increasingly widely heard.

a tradition that antedates true decimal thinking. Such practices cannot be expected to change overnight . . . but, even now, our hardware store tells me that if they forgetfully order a gross, they frequently receive a hundred (packaged) and 44 extras.

Hard conversion to metric sizes, when it comes, carries with it the challenge of identifying and selecting appropriate and simple ranges of sizes, convenient to buy and facilitating comparisons. Canada's reduction in toothpaste tube sizes, from a pre-metric 29 to 5, frequently is cited as a good instance of such "product rationalization." From a 25 ml "personal" size to a 150 ml "family" size, with three sizes inbetween (50 ml, 75 ml, 100 ml), "metric" toothpaste meets all needs . . . and demonstrates how the marketplace can be tidied up at the time of metric conversion. Such a change, of course, greatly facilitates price comparisons, and has been popular with consumer groups.

A certain vigilance may be needed, however. Without true comprehension of the decimal nature and strength of SI metric, the best of intentions can go very wrong indeed. The 250 ml measuring cup, for example, is unfortunate, halving, as it does (and recipes frequently are halved) to 125 ml (three significant figures), quartering to I hesitate to say what . . . surely, 200 ml would have been better. Even more horrendous is one American wine and liquor "fill" . . . by any other name, three-sixteenths of a litre.

Metric conversion can lead to strange hybrids . . . temporarily, one hopes. In Canada, I find, you currently can buy plywood sheets that are 4 feet by 8 feet . . . by 6 millimetres!

The challenge, in these regards, I submit, is a truly optimal conversion . . . one that, duly weighing cost factors, possible efficiencies, and short- and long-term benefits, guided by what Americans have aptly termed "the rule of reason," will set us up, as effectively as possible, for a sane and enduring metric tomorrow.

Fact 6. Strong national commitment to orderly SI conversion doesn't necessarily win votes, but it certainly helps everyone to get on with the job.

The most efficient, most thorough, SI conversions have taken place in nations having, from the start, strong national commitment and acute awareness in the general public, consumer sectors. The Republic of South Africa has typified such priorities and such an approach. I have not the least doubt that millions of rands, and an infinitude of inefficiencies and annoyances, have been saved or spared as a direct result. The opposite extreme has been all too well typified by the United Kingdom, where a less than vigorous commitment and a reasoned downplaying of the relevance to the consumer have resulted, in the second decade of "conversion," in circumstances aptly characterized as pathetic. Nationally and in most provinces, Canadians too have wanted for a firm commitment from their men at the top. Americans, in particular, have seen metric hopes

founder, if only temporarily, for a lack of priorities, of a sense of urgency, and of vigorous leadership, on the part of governments. Target dates and critical paths do much to spur interest, enthusiasm, and real action. You get more headlines by being against metric than for it, of course . . . be that as it may, national, industrial, and individual interests clearly are involved.

Leadership and commitment at the top, a time line, an overall plan, and a good measure of voluntary consensus, are equally desirable at all levels, of course--a nation, a state, a community, an industry, a school system, or a home. The challenge is there . . . and it's later than many of us think.

Fact 7. Metric conversion, as a task, will expand to take all the time, human resources, and funds available for it, but can and should be approached in an efficient, optimal manner.

That is self-evident, I fear.

The real first task, I feel, must be to determine who does what, and why, and who pays the bill. National interest, self-interest, "freedom," "voluntarism," all are inextricably intertwined. Lots of luck! Your basic democratic process has come to grips with problems far more fundamental, and far more difficult, than this.

Canada's approach, for the record, has laid great stress on "voluntary concensus," following a policy, in general, of letting costs, and benefits, "lie where they fall."

After five years of vigorous wrestling with perceived realities of metric measures and of SI conversion, both for my own mental stimulation and in the interest of my students, those, my friends, are the "facts of life and living" that I presume to place before you this New Orleans afternoon.

I wish you well in this, your Fourth International Conference on Metric Education, and assure you of my continuing interest and support as you pursue your deliberations.

* * *

"Way down south in New Orleans . . . ." Like some of you, I ventured southward this weekend in fond hope of briefly escaping winter . . . and scarcely relish the announced prospects of damp breezes and chilling rain. I'm going to "slip down the coast a few hours," in the strange reckoning of this, a jet age. There's warmth, I know, in tropical lands remaining from an Empire on which (as the Victorians so aptly phrased it) the sun never sets. I seek that warmth. I need that sun. There should, of course, be a good measurement story in it all, which I trust we'll someday have a chance to share.[8]

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[8]See "Rice by Weight, Other Produce by Bulk, and Snared Iguanas at So Much per One," A Talk on Measurement Standards and on Metric Conversion, Written in Belize City and Recorded for Broadcast at the Studios of Radio Belize. Text available from the author on request.